Winter Legumes

FOR GREEN MANURE IN THE COTTON BELT

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THE USE OF WINTER LEGUMES for green manure in the Cotton Belt has greatly increased in recent years. Austrian winter peas, hairy vetch, and smooth vetch are the crops most used, but crimson clover, bur-clover, and sourclover are used in limited areas.

A legume green-manure crop reduces erosion and the leaching of plant food. It improves the physical condition of the soil by the addition of organic matter and through the nitrogen-gathering bacteria adds plant food. It also increases yields of subsequent crops grown with it in rotation.

Winter legumes should be inoculated at the time of seeding. Commercial fertilizer consisting largely of superphosphate should be used, especially when growing a legume crop on land for the first time. Barnyard manure also increases the growth of winter legumes and greatly aids in getting the plants inoculated.

Seedings should be made the latter part of September or early in October. Earlier seeding may result in injury by nematodes, and later plantings often result in poor stands and growth.

The green-manure crop should be turned under 2 weeks preceding planting corn and 3 weeks before planting cotton.

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WINTER LEGUMES FOR GREEN MANURE IN THE COTTON BELT

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INTRODUCTION

THE USE OF WINTER LEGUMES for green manure in the Cotton Belt has greatly increased in recent years, largely on account of demonstrations by the State and Federal experiment stations and the practical experience of farmers. The value of this practice and the best crops for the purpose have been indicated by these experiments.

By legume is meant a plant that bears pods like the pea or the bean. These pods are 1-celled and usually split in two pieces.

By winter legume is meant a legume plant that has the ability to survive winter temperatures ranging from 60° to 15° F. or lower and that makes more or less growth during this period.

The term "green manure" used in a strict sense means a crop turned into the soil green or in an immature state for the purpose of soil improvement. A more liberal use of the word, and one that is not uncommon, denotes any crop material left on the surface or turned into the soil, whether in a green or dry state.

A crop that is grown to be left on the surface rather than turned into the soil is usually called a cover crop, but this term is used more or less interchangeably with green manure.

LEGUMES NOW COMMONLY USED

Six winter legumes are now used for green manure more or less commonly in the Southern States. These are hairy vetch, smooth vetch, Austrian winter pea, crimson clover, bur-clover, and sour-clover. Sourclover has proved adapted to the region that includes

California, Arizona, the Delta area of Louisiana and adjoining States, and the blacklands of Alabama and Mississippi.

Crimson clover is best adapted to the more northern part of the Cotton Belt and is now grown most extensively in the region that extends from northern Mississippi, Alabama, Georgia, and South Carolina, north to Kentucky and New Jersey.

Bur-clover is most extensively used in the Mississippi Delta section but is grown throughout the South, except on the real sandy lands. Austrian winter peas, smooth vetch, and hairy vetch seem to be universally adapted and are the crops most commonly used.

There are no definite figures indicating the acreage of winter legumes used for green manure in the Cotton Belt. Estimates have been made from the amount of seed known to have been shipped into the several States, and figures have been compiled in a few States from county agents' reports and from such other sources as were available. It is estimated that the total acreage of winter legumes planted in the Cotton Belt in 1929 was about 250,000 acres, and in 1939 about 2,000,000. The total acreage planted for green manure would be much above these figures, as large quantities of rye and other cereals are used each year for this purpose.

VALUE OF GREEN MANURES

A number of reasons are commonly advanced for the use of green-manure crops. Some of these are based on very obvious facts, but others are less apparent.

In regions where soils wash badly a growing crop on the land during the season of heavy rainfall will prevent much washing. It is well known that soils containing a high percentage of organic matter will wash less than those low in organic matter. Thus a green-manure crop will prevent much washing both during the period of its growth and for the time that it increases the organic content of the soil.

With the addition of organic matter there is usually an improvement in the physical condition of the soil. This is noticeable in the increased moisture-holding capacity and the ease with which the soil can be worked when it is being plowed or disked.

In addition to improving the physical condition of the soil and preventing washing, a winter green-manure crop prevents leaching of plant food during the winter season. When there is no growing crop on the land the plant-food elements that become available through decomposition or otherwise are lost. When a growing crop is on the land these elements are taken up by the crop and are again made available when it is turned into the soil. In this way a green-manure crop conserves fertilizer. A legume crop, used for green manure, not only takes up the plant food that otherwise would leach from the soil but also adds nitrogen that it takes directly from the air through the symbiotic bacteria on its roots.

A fertile soil has a large number of micro-organisms. In order that these may flourish it is essential that organic matter be supplied to the soil. Organic matter also has an effect on the mineral elements of the soil and aids in making them available as plant food.

It has long been recognized that legumes in rotation with non-legumes are beneficial to the latter. Nonlegumes in continuous cul-

ture give smaller yields than are obtained from nonlegumes in rotation with legumes. This increase is due in great part to the nitrogen that the legume takes from the air, but aside from this there appears to be a beneficial effect due to other unexplained factors that persist after the fertilizing material of the plant has disappeared.

The net results accruing from the use of winter legumes are increased yield of the crop that immediately follows and lessened but noticeable increases in succeeding crops for several years.

INOCULATION

Under Cotton Belt conditions all winter legumes need to be inoculated with nitrogen-fixing bacteria. This can be accomplished by the use of commercially available pure cultures, directions for which will be found on the package, or by the use of soil from a field that has recently grown the crop which it is desired to inoculate.

When soil is used it can be mixed with the seed at the rate of a half bushel or more per acre and be drilled with a 3-row drill or with a "knocker" fertilizer distributor. The soil should be dried and sifted to make it run freely, or it can be applied broadcast at the rate of 1,000 pounds per acre and be worked into the soil ahead of seeding. Many farmers think it is good insurance to use both the commercial culture and soil.

One of the most essential things in inducing inoculation and good subsequent growth of winter legumes is the use of fertilizers. Commercial fertilizer, unless it is basic slag, should not come in contact with inoculated seed, as it may injure the inoculating organism; however, a general application of fertilizer preceding or at the time of seeding is essential to success. If the summer crop preceding the winter legume has been well fertilized, the quantity applied to the winter-legume crop can be greatly reduced or in some cases entirely omitted.

When the winter legume is to be planted on lands where it has not grown previously, and following a summer crop that has only been lightly fertilized, the use of superphosphate will help the inoculation.

Barnyard manure is very effective in inducing inoculation and should be used whenever available.

FERTILIZERS

The successful growing of a green-manure crop on the poorer lands of the South requires the use of commercial fertilizer. Of the common fertilizer constituents phosphoric acid is usually the most needed; however, on the poorer lands the addition of nitrogen will help very materially, and this should be used until a winter-legume green-manure crop has been grown successfully. The fertilizer should be applied in the fall just prior to, or at the time of, seeding the green-manure crop.

The amount of fertilizer used will vary with soil and cropping conditions. When the summer crop preceding the winter legume is heavily fertilized, little, if any, fertilizer will be needed on the winter legume. If the soil is poor and the summer application of fertilizer is light, the use of 200 pounds or more of superphosphate, or 300 of basic slag and 50 pounds of sodium nitrate or ammonium sulfate

or an equivalent nitrate fertilizer is advisable. When growing a winter legume for the first time on land that has been only moderately fertilized it is advisable to use as much as 400 pounds of superphosphate or 600 of basic slag per acre and 100 pounds of a nitrate fertilizer.

Lime at the rate of 1 to 2 tons per acre is used occasionally in addition to the fertilizers previously mentioned, and increased yields have sometimes followed this practice.

PREPARATION OF THE SEEDBED

The largest acreage of winter legumes follows cotton, in which case little or no preparation of the soil is necessary. This is also the case where the winter legumes are preceded by cowpeas, soybeans, or Spanish peanuts. Under such conditions the seed is sown broadcast and disked in, provided the previous crop has been harvested sufficiently early. A crop of tobacco or melons may also be followed by winter legumes using the same method. If for any reason the land needs flat breaking the preparation is more expensive and requires more time.

On clayey soils where there is considerable weed growth or the soil is packed hard, plowing or heavy disking will be essential in order to give a good seedbed. With crops, such as field peas, that have large seeds there is little danger of covering the seed too deep, but with crops such as crimson clover, which have small seeds, it is necessary for best results to work the soil down into a firm condition before seeding.

SEEDING

The best time for seeding will vary with latitude and seasonal conditions, but in general seeding should be done if possible during the last half of September in the northern part of the Cotton Belt, and early in October in the southern part. Early seeding is desirable in order to get as much fall growth as possible, but where nematodes are numerous early seedings may be seriously damaged. In general, seedings made about the first of October escape with but little nematode injury. In severe winters, however, seedings made as late as the first of December will usually result in poor stands due to winterkilling, and but little growth will be made by the time the crop should be turned down for corn or cotton. Results at the Alabama Agricultural Experiment Station show that winter legumes planted October 1 made twice the yield by April 1 of the next year as the planting made November 1.

The quantity of seed needed to give a good stand has been reasonably well determined by experimental work. Local variations in the soil, preparation of the seedbed, etc., are factors influencing the rate of seeding, but in general the range of variation in the quantity needed is not great.

The quantity of seed per acre that is considered advisable under average Cotton Belt conditions is shown herewith. Farther north or where winterkilling and other factors tend to reduce the stand more seed is recommended. When a seed drill is used a smaller quantity of seed is required than when the seed is broadcast, and

thoroughly prepared land requires less seed than land that is rough and poorly prepared. Under favorable conditions the least quantity of seed indicated can be used, but under less favorable conditions the quantity should be increased accordingly.

QUANTITY OF SEED TO USE PER ACRE

Fenugreek (*Trigonella foenumgraecum*)	pounds	20–30
Hairy vetch (*Vicia villosa*)	do	20–30
Smooth vetch (*Vicia villosa* var.)	do	20–30
Narrowleaf vetch (*Vicia angustifolia*)	do	20–30
Woollypod vetch (*Vicia dasycarpa*)	do	25–35
Monantha (Oneflower) vetch (*Vicia articulata*)	do	30–40
Austrian winter pea (*Pisum arvense*)	do	30–40
Common vetch, Oregon (*Vicia sativa*)	do	40–50
Hungarian vetch (*Vicia pannonica*)	do	40–50
Purple vetch (*Vicia atropurpurea*)	do	40–50
Bard vetch (*Vicia monantha*)	do	40–50
Bittervetch (*Vicia ervilia*)	do	40–50
Tangier pea (*Lathyrus tingitanus*)	do	60–70
Horsebean (*Vicia faba*)	do	60–90
Yellow lupine (*Lupinus luteus*)	do	60–80
Blue lupine (*Lupinus hirsutus*)	do	60–80
Black medic (*Medicago lupulina*)	do	10–15
Sourclover (*Melilotus indica*)	do	15–20
Crimson clover (*Trifolium incarnatum*)	do	15–20
Southern bur-clover (*Medicago arabica*) (unhulled)	bushels	5– 6
Tifton bur-clover (*Medicago rigidula*)	do	4– 5
California bur-clover (*Medicago hispida*)	pounds	15–20
Serradella (*Ornithopus sativus*)	do	15–20

The seed may be sown broadcast or with a drill in cotton middles. If broadcast, the seed may be covered with a 1-horse plow or cultivator or with a 2-horse cultivator that straddles the row and has disks or plows that do a good job of covering. If drilled, the 3-row 1-horse drill serves the purpose, but the middle hole may be closed, because the crop does not grow well in the center of the row, especially where the middle is low. For vetch the sorghum plate should be used, but winter peas need a larger plate. Some farmers go twice to the row with a 1-row drill or with a fertilizer distributor that sows a mixture of seed, soil, and basic slag. Superphosphate is not mixed in this way, because of danger of killing the inoculation.

To avoid injury to the cotton, the drilling should be done immediately after a picking. In the lower part of the Cotton Belt the cotton is picked out before the winter legumes are planted. Where conditions permit the use of larger drills, they save much time in planting the crop.

Short and narrow plows on the 1-horse drills make only a small furrow, but even this should be filled with a smoothing attachment, such as a scratcher, chains, or a small chain harrow. This is particularly necessary for vetch, because the young plants flatten out on the ground, and the first heavy rain washes the dirt and sand in on them. This danger is greater on sandy lands.

Drilling when properly done gives a larger yield of green-manure crop than broadcasting, just as it does with small grains. There is also less "heaving" of plants in freezing-thawing weather on clay soils if the drill is used.

TURNING UNDER

When should a green-manure crop be plowed under for a spring-planted crop? This is a question that can be answered only in a general way. If done too early it will have too little fertilizer value, and if done too late the heavy growth will be difficult to turn under and cover properly, or the evaporation of moisture through the leaves of the plants may have pumped the moisture from the soil, leaving it hard and dry. Also, if the crop is hairy or smooth vetch there is danger of injury from vetch worms (same as corn earworms) after the pods begin to form.

When the weight of green vetch is 12 pounds per square of 10 by 10 feet, the nitrogen in it, calculated to an acre basis, is equivalent to about 300 pounds of nitrate of soda. For Austrian winter peas 14 pounds will have nearly the same nitrogen equivalent. This is sufficient for a good crop of corn and ordinarily ought to be plowed in without further waiting. To delay turning beyond this point in order to get 50 to 100 percent more nitrogen means running risks of dry weather, of unwieldy growth, of greater difficulties in getting stands of corn, and of possible injury from vetch worms. In their zeal to get the maximum quantity of nitrogen many farmers wait too long and run into difficulties they do not foresee.

When the growth is at the stage mentioned, it can be turned under with an ordinary 2-horse plow with a 12-inch rolling colter attached. If the growth is very heavy, larger plows and more power will be needed. The 3-horse sulky plow with rolling colter is an excellent implement for the purpose. Tractor plows, whether of disk or mold-board type, will do the job.

It is known that the rate of decomposition of vegetable matter in the soil varies with changes in temperature and moisture, and aside from these factors one must take into consideration the stage of maturity of the green-manure crop. An immature crop decomposes more rapidly than a mature crop, and allowance for this must be made. Experimental work has indicated that a green succulent winter-legume crop should be turned down about 2 weeks before planting corn and 3 weeks before planting cotton. In the case of tree crops the time of active growth of the tree can perhaps be used as a good guide for turning down or otherwise disposing of the green-manure crop. Decomposition should take place just preceding and during active growth of the tree. In this connection it should be remembered that with average spring conditions a succulent green-manure crop turned into the soil decomposes and practically disappears in from 6 to 8 weeks. A mature crop decomposes somewhat more slowly, and when the crop is worked into the soil lightly or is left on the surface as a mulch the period of decomposition is extended accordingly, and erosion will be greatly reduced.

PREPARING LAND FOR SUBSEQUENT CROPS

Most of the winter-legume land is broken flat in the spring and harrowed soon after. Then after a wait of about 2 weeks it is listed, and corn is planted in the water furrows, though sometimes the land is leveled and the crop is planted on the level. Sometimes it is "hard bedded," which means that two furrows are thrown together

at intervals of 4 feet, or whatever the width of row happens to be, then the ridge left in the middles is plowed out with a turnplow, and corn is planted immediately in the water furrow. This method is better adapted to sandy lands than to clay. One advantage of this method is that corn can be planted without waiting for the legume to decay, but whether, in the long run, it is advisable to do so is still an open question.

In preparing winter-legume land for cotton it should be flat broken and then, after a wait of 3 weeks or thereabouts, low beds should be prepared and the cotton planted in the usual way.

VOLUNTEERING A WINTER LEGUME

Few winter legumes will mature seed under Cotton Belt conditions and have enough hard seed to carry over and give a good volunteer stand the following year. However, the bur-clovers can be handled in this manner quite successfully when the planting period of the succeeding crop can be delayed until late spring, so that some seed will have matured. A common practice in the Mississippi Delta section is to allow the bur-clover to mature seed 1 year in 5 and to follow the bur-clover in that year with late-planted corn. In this way enough seed of bur-clover is assured for volunteering the next 4 years. It is also possible to leave strips of the bur-clover undisturbed at the time of planting the summer crop, with the idea of cultivating or turning down these strips after the bur-clover seed has matured and in this manner provide seed for the succeeding volunteer crop. Crimson clover can be handled by this latter method by plowing the crop under fairly deep when ripe and later in the summer working it to the surface. When conditions are right this will give a good stand and is a satisfactory practice.

Narrowleaf vetch matures seed early and volunteers readily in waste places throughout the South. It can be successfully grown in orchards and other places where considerable organic matter has been allowed to accumulate, and its use should be extended. Regularly cultivated lands low in organic matter, however, are poorly adapted to narrowleaf vetch.

Hairy vetch under favorable conditions will mature enough seed to volunteer, but the comparatively late season of maturing and the likely damage by the corn earworm usually make the volunteering of this crop inadvisable.

All the other common winter legumes that make sufficient winter growth for green manure either fail to mature enough seed under southern conditions or lack sufficient hard seed to serve as volunteer crops.

YIELDS OF GREEN MANURE

The yield of any winter green-manure crop will vary with seasons, with different soils, and with other local conditions. This is especially true when the green-manure crop must be turned down early in order to be out of the way for a succeeding summer crop.

It is desirable to have a large green-manure crop yield, and in determining the time of planting and the crop to use this should be given first consideration.

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In table 1 is given the green weight of hairy vetch and peas as grown in connection with experimental work at Tifton, Ga., and Gainesville, Fla.

TABLE 1.— *Yields per acre of hairy vetch and Austrian winter peas at Tifton, Ga., and Gainesville, Fla.*

Place	Growing period	Green weight		
		Hairy vetch	Austrian winter peas	Abruzzi rye
		Pounds	*Pounds*	*Pounds*
Tifton [1]	Oct. 15 to Mar. 1	11,888	12,313	5,441
	Oct. 15 to Mar. 15	16,289	14,716	7,661
Gainesville [2]	Oct. 9 to Mar. 8	4,967	5,726	

[1] 13-year average yields. No fertilizer was used with the green-manure crop, but it was used with the preceding corn and cotton crops.
[2] 1 year's results. No fertilizer was used with the green-manure crop or the corn crop preceding.

Yields based on air-dry weights and reported from the Alabama Agricultural Experiment Station at Auburn for a 5-year period when planted October 1 and November 1, respectively, and harvested at the same date in early spring, are as follows: Austrian winter peas planted October 1, 3,317 pounds, and planted November 1, 2,418 pounds; hairy vetch planted October 1, 3,271 pounds, and planted November 1, 2,476 pounds. At Clemson College, S. C., for the period from October 1 to February 12, hairy vetch yielded 2,190 pounds dry matter and Austrian winter peas 6,620 pounds. The green weight probably would be about 5 times the dry weight. Louisiana reports yields in experimental plantings at Baton Rouge on Oliver silt loam ranging from 3½ to 6½ tons green weight per acre for both Austrian winter field peas and hairy vetch, and in the delta of northeast Louisiana several times that amount was obtained.

Yields of Austrian winter peas and hairy vetch in pecan groves in Florida ranged from 10,000 to 20,000 pounds green weight. Other general data available indicate that a wide range in yield may be expected.

WHAT CROPS TO PLANT AFTER WINTER LEGUMES

Corn is the principal crop to plant after winter legumes and is likely to remain so, although in the southern part of the Cotton Belt much cotton is planted after them. Corn can be planted within wider limits of time than cotton, and this gives more time within which to turn under the legume. Cotton land is usually prepared early, much of it before the legume is large enough to turn under; but if the art of getting a large early growth of the legume is learned, there will be time to prepare and plant part of the cotton crop thereafter.

Where cotton and corn are rotated it is easier to plant the winter legume after the cotton than after the corn, which means that corn will naturally follow the legume. The presence of summer legumes in the corn and the frequent knocking down of the cornstalks across the rows by storms makes it difficult to interplant the winter legume between the rows; therefore the next year's cotton is not preceded by

a winter legume. However, where corn is harvested for silage, the conditions are ideal for planting winter legumes, and cotton may follow thereafter.

Other crops, such as sweetpotatoes, sorghum, cowpeas, soybeans, etc., that can be planted in May or June may follow winter legumes.

INCREASED YIELDS OF CORN AND COTTON FROM USE OF GREEN MANURE

Increased yields of corn and cotton have resulted from the use of green-manure crops whenever a good yield of the green-manure crop has been obtained and handled in season. The general experience of farmers as well as experimental results indicate the value of this practice. At Tifton, Ga., several legumes were used in comparison with Abruzzi rye and no legume, with the results given in table 2. Through a 4-year period the average yield for the plots using a winter-legume green manure was consistently higher than on the plots using rye or no legume, the difference in yield being sufficiently great to justify considerable expense on the green-manure crop.

TABLE 2.—*Yields of cotton and corn at Tifton, Ga., following winter green-manure crops*[1]

[Yields given are an average for 13 years]

Green-manure crop used	Acre yield, with complete and incomplete fertilizer			
	Corn		Seed cotton	
	N-P-K [2] 0-10-4 [2]	N-P-K 2-10-4 [2]	N-P-K 0-9-5 [2]	N-P-K 3-9-5 [2]
	Bushels	*Bushels*	*Pounds*	*Pounds*
Austrian winter pea	48.6	46.7	1,361	1,342
Hairy vetch	46.0	47.9	1,278	1,413
Monantha vetch	45.6	47.7	1,315	1,476
Abruzzi rye	30.0	33.7	1,087	1,299
No green manure	30.2	33.6	771	1,032

[1] Green-manure crops were sown Oct. 1 and turned down Mar. 1 for cotton and Mar. 15 for corn. Fertilizer used, 500 pounds per acre for corn and 1,000 pounds per acre for cotton. No fertilizer was used with the green-manure crop.

[2] Percentages, respectively, of nitrogen (N), phosphorus (P), and potassium (K).

The experiment station at Clemson College, S. C., reports yields comparable to those obtained in Georgia. The average yield of corn per acre for the 2 years when a side dressing of sulfate of ammonia of 100 pounds per acre was used was 13.8 bushels on the rye plots and 27.3 and 25.7 bushels for Austrian winter pea and vetch plots, respectively. In the case of the plots receiving no side dressing, the yield on the rye plot was 5.3 bushels and on the Austrian winter pea and vetch plots 25.3 and 18.5 bushels, respectively. In this experiment the winter crop received 200 pounds of superphosphate and 50 pounds of muriate of potash.

At the experiment station at Auburn, Ala., the increased yield of corn due to plowing down vetch for a 5-year period was 15.5 bushels per acre when the vetch was turned March 25, 22.2 bushels when turned April 5, and 22.4 bushels when turned April 15. For cotton the increase was 593 pounds of seed cotton per acre when the vetch was turned March 25, 534 pounds when turned April 5, and 460 pounds when turned April 15.

The writers made a survey of farms using winter legumes in South Carolina, Georgia, and Alabama and obtained estimates from farmers of the increased yields of corn and cotton, due to the use of these legumes, for a 5-year period. The survey covered 353 cases of corn following winter legumes and embraced 4,145 acreas of that crop. The average increase in yield of corn for this acreage was 14 bushels per acre. Also, in 147 cases of cotton after winter legumes, covering 1,877 acres, the average increase due to the use of these legumes was 100 pounds of lint cotton per acre.

HOW MANY ACRES OF WINTER LEGUMES PER MULE?

The average farmer in the Southeastern States who has had experience with winter legumes says that 5 acres to the mule is practicable, but he usually falls below this figure in his own practice. It is physically possible, however, to do much better than this. By the use of plenty of seed, early planting, fertilizers, and the legume that makes the best early growth, one may have such a good early growth that turning can be commenced a week or 10 days in advance of the usual time. The Alabama Agricultural Experiment Station has already been quoted to the effect that plantings of winter legumes on October 1 have made twice the growth by April 1 of the next year as have those planted November 1; also, the average yield of Austrian winter peas on April 1 from plantings made October 1 for a 5-year period was 9,136 pounds green weight per acre, whereas hairy vetch gave 6,546 pounds for the same period of planting and harvesting.

The season can be further extended by the use of other crops. In late May or the first of June a few acres of bur-clover or crimson clover can be plowed down after the former is ripe and the latter harvested for seed and planted to some late crop. If the soil is suited to bur-clover that legume will perpetuate itself in a 2-year rotation of late-planted corn 1 year and cotton the next. Some seed of the bur-clover will mature before the crop is turned down, and the "hard" seed will live over in the soil 2 or more years.

Instead, therefore, of 5 acres to the mule, 3 or 4 more can be added early in the season and 2 or 3 more late in the season, making a total of 10 or 12 acres to the mule in all. Livestock men who keep legumes pastured may have a still larger acreage, and those who have tractors can handle a large percentage of land in winter legumes.

There are, of course, large areas in the South where neither crimson clover nor bur-clover do well, but there are possibilities with hop clover and Carolina clover.

IS IT PRACTICABLE TO SAVE SEED OF WINTER LEGUMES IN THE SOUTH?

Wherever crimson clover grows well the seed can be saved by every farmer. Methods of doing this will be found in Leaflet 160.

The production of Austrian winter pea seed and hairy vetch seed is irregular and uncertain, and yields are small even when obtained. Corn earworms sometimes attack hairy and smooth vetch and defoliate them. Farther south there is more danger from the worms. If production is attempted, however, watch should be kept for the

worms every day after pods begin to form, and at the first sign of them the crop should be plowed down as a fertilizer. If the worms do not appear the crop may be kept for seed. In the Piedmont of North Carolina vetch seed has been grown more or less successfully until recent years, when the vetch weevil has greatly damaged the seed crop, making it less profitable.

Winter peas and the aforementioned vetches are sometimes harvested for seed in the South by raking the vines when they are ripe or dead ripe. At this time the vines break off at the ground. They can then be threshed or knocked out with a flail. Shattering is greater with hairy and smooth vetch than with Austrian winter peas and monantha vetch.

RESIDUAL EFFECT OF WINTER LEGUMES

Although there are only limited experimental data on the residual effect of winter legumes, there is no doubt that there is such an effect.

FIGURE 1.—Oats on the farm of D. C. Sims, Lafayette, Ala. At the right, oats following cotton, which was planted after Austrian winter peas used as a green manure. At the left, oats following cotton, which was not preceded by any winter legume.

At the Central Experimental Farm, Ottawa, Canada, a crop of clover gave an increase in the corn, oats, potatoes, carrots, and sugar beets that were planted in successive years. In the latter year the potato increase was 20 bushels per acre, the carrots 11.16 tons per acre, and the sugar beets 13.7 tons per acre.

At the Alabama Agricultural Experiment Station the vetch turned under increased the corn yield by 9.9 bushels per acre for vetch turned March 25, 19.5 bushels per acre for that turned April 5, and 21.7 bushels for that turned April 15.

If the grower merely comes out even, financially, on the first crop after winter legumes, he will still find their use advantageous because of their influence on the next year's crop.

Figure 1 shows the effect of Austrian winter peas turned under in the spring on the crop of oats the following year. Cotton occupied all this land the year preceding the oat crop. The winter peas occupied the land on the right but not on the left.

INSECTS AND NEMATODES

In the Cotton Belt but little difficulty with insects has been encountered in growing winter legumes except in cases where the crop has been allowed to stand late in the spring. Serious damage to hairy vetch by the corn earworm has resulted when the crop has been allowed to stand late in the hope of getting a seed crop. No method of control has been discovered for the vetch weevil, which in the past few years has done serious damage to the vetch seed crop in North Carolina.

Aphids also may do serious damage to winter green-manure crops that are allowed to continue growth late in the spring. However, the proper season for turning the green-manure crop down for cotton or corn is sufficiently early so that usually but little, if any, damage is to be expected. In the northern part of the Cotton Belt aphid damage may be expected after April 15, and in the southern part the last of March or early April. When aphids appear in abundance the green-manure crop should be turned under or disked down at once.

Experimental work of the Alabama Agricultural Experiment Station indicates that the damage to the corn crop by the southern corn rootworm is increased when following a green-manure crop. However, little or no damage resulted from plantings made April 30 and later. In latitudes farther north the date of planting to avoid damage by this insect will be somewhat later. This matter is discussed in Farmers' Bulletin 950.

The winter legumes commonly used in the Cotton Belt are all subject to attack by nematodes, and under favorable conditions serious damage may result. All other winter legumes used in experimental planting, so far as observations have been made, are hosts of nematodes. Nematodes are most active during warm weather, and serious damage to the green-manure crop can be avoided by delaying the planting until the last of September or early October, thus bringing the growing season entirely into the cooler part of the year. This has been indicated under the heading Seeding.

LEGUMES ADAPTED TO THE COTTON BELT

HAIRY VETCH

(*Vicia villosa* Roth)

Hairy vetch is one of the oldest and most commonly used green-manure crops of the Cotton Belt. Being one of the most winter hardy of the vetches, it seldom suffers any winter injury. It is usually considered as a winter annual, although it often carries over into the second year as a biennial when sown in the spring. The stems are comparatively weak or viny, ascending only with support. It has a higher minimum or zero growing point than other vetches

that are less winter hardy, so that in seasons with a low mean temperature less growth may be expected from this variety than from others with a lower zero growing point. In mild winters, however, or winters having a high mean temperature, hairy vetch may yield as heavily as any less hardy variety. The seed of this variety cannot be distinguished from that of smooth vetch, and the two varieties are being sold under the name hairy vetch. In growth, however, the two varieties are very distinct, the hairy vetch having long hairs

FIGURE 2.—Hairy vetch in mixture with rye, showing the general habit of growth of the vetch.

on the stems and leaves, whereas the smooth vetch has fewer and less conspicuous hairs. A tufted growth at the ends of the stems of hairy vetch is also characteristic. The flowers of hairy vetch are a little larger than those of smooth vetch and of a less reddish-purple color (fig. 2).

SMOOTH VETCH

(*Vicia villosa* Roth)

In general, smooth vetch is like hairy vetch and is a variety of the same species but differs in lacking the tufted growth at the ends of the stems and in having fewer hairs or less pubescence on the stems and leaves. The flowers are of a more reddish purple than those of hairy vetch and somewhat smaller. Smooth vetch is winter hardy in the Southern States and as far north as Washington, D. C., but it cannot be grown so far north as hairy vetch. It has a lower zero growing point than hairy vetch and for this reason can be expected to make winter growth in seasons and at times too cool for hairy vetch. In experimental work smooth vetch has been one of the best

winter legumes under southern conditions. During the last few years seed of this vetch has been imported in considerable quantity under the name hairy vetch. In commercial plantings in the South it has made somewhat better growth than hairy vetch and is to be preferred to that variety.

WOOLLYPOD VETCH

(*Vicia dasycarpa* Ten.)

Although woollypod vetch is of proved value for Cotton Belt conditions and has been used in experimental plantings for a good many years and was even at one time grown commercially in small quantity, it is not to be found in the trade at the present time. The reason for this seems to be a lack of interest in green-manure

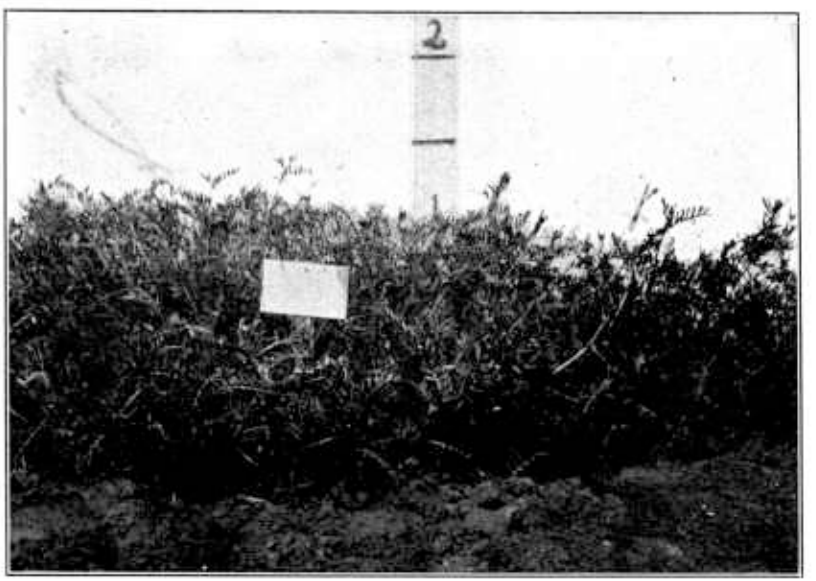

FIGURE 3.—Woollypod vetch in an experimental planting, showing general habit of growth.

crops in the South at the time this vetch was commercially available.

In general appearance and in cultural requirements woollypod vetch is very much like smooth vetch. In fact, when growing in the field the two can be very readily mistaken one for the other. The flower of woollypod vetch is a little smaller and a little deeper red than that of smooth vetch. In size and color the flowers of smooth vetch are halfway between those of hairy vetch and woollypod vetch. Unlike smooth vetch, the seed of woollypod vetch can be readily distinguished from that of hairy vetch. It is oval instead of nearly spherical, as in hairy vetch, and has a groove along the dividing line of the seed scar which is not present in hairy or smooth vetch. The seed of woollypod vetch is usually a little larger than the seed of

hairy or smooth vetch, but this difference cannot always be depended upon. The minimum temperature at which woollypod vetch will make growth is lower than with hairy vetch, and in this respect it is more like smooth vetch. It is a vetch that can be widely used in the Cotton Belt (fig. 3).

MONANTHA VETCH

(*Vicia articulata* Willd. [*V. monanthos* (L.) Desf., not *V. monantha* Retz.])

In general habit of growth monantha (oneflower) vetch is similar to other vetches. It has finer stems and leaves than hairy vetch and is one of the earliest maturing of the vetches. The minimum temperature at which it will make growth is lower than for hairy or smooth vetch or Austrian winter peas, and it is one of the best winter legumes for making growth during winter or periods with a low mean temperature. In point of winter hardiness it is not to be compared with hairy vetch, or Austrian winter peas, or even smooth or woollypod vetch. It cannot be safely grown in the northern part of the Cotton Belt and is recommended for use only in Florida, the southern part of Georgia, Alabama, and similar territory.

NARROWLEAF VETCH

(*Vicia angustifolia* Grufberg)

Found as a weed by the roadside and in waste places throughout the Cotton Belt, narrowleaf vetch is like most other vetches and is closely related to common vetch. Its season of maturity is early, and for this reason it ripens seed regularly under southern conditions. The percentage of hard seed in this species is quite high, and this carries over in the soil, giving a volunteer crop from year to year. When planted under field conditions and given ordinary cultural attention it has seldom succeeded. It seems to require some protection, and possibly the accumulated organic matter supplied by weeds or grass, with which it commonly volunteers, is necessary for its growth. It can be recommended for growing in mixture with Bermuda grass or Johnson grass for hay or for volunteering in orchards as a winter crop where a heavy grass growth is allowed to accumulate during the latter part of summer. Narrowleaf vetch will make growth under about the same temperature conditions as bur-clover or hairy vetch.

COMMON VETCH

(*Vicia sativa* L.)

Common vetch is a semiviny plant having slightly larger leaves and stems than hairy vetch; being less winter hardy than that species, it often winterkills under Cotton Belt conditions. The minimum temperature at which common vetch will make growth is lower than that for hairy vetch or Austrian winter peas, and for this reason it is to be preferred where it is winter hardy and is adapted. This vetch is being used in commercial plantings in the lower Mississippi Delta section, where the hardier varieties have given good results, and it

seems probable that with proper cultural treatment it can be grown successfully over a much wider area (fig. 4).

HUNGARIAN VETCH

(*Vicia pannonica* Crantz)

Hungarian vetch is a comparatively new species that has become commercially established in western Oregon. Experimental plantings in the Cotton Belt have indicated that it is not so well adapted to sandy lands as other vetches, but on heavy lands it has given good results. It is entirely winter hardy throughout the Cotton Belt and as far north as Washington, D. C. The minimum temperature at which it will make growth is about the same as for burclover and hairy vetch. Results up to the present time suggest that it may have value for use on the heavier lands of the northern part of the Cotton Belt and in the Mississippi Delta section (fig. 5).

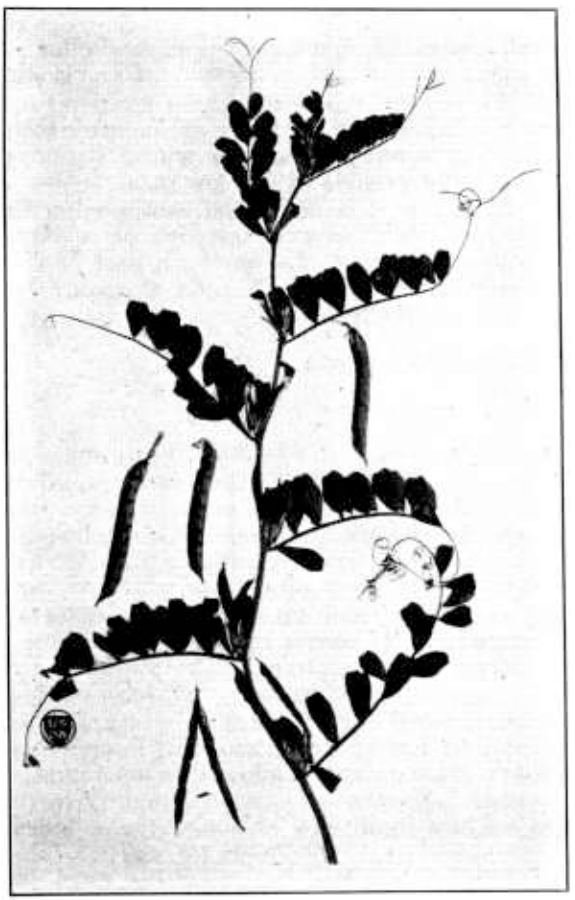

FIGURE 4.—Stem and seed pods of common vetch.

PURPLE VETCH

(*Vicia atropurpurea* Desf.)

In general appearance purple vetch is similar to hairy vetch, but in winter hardiness it is very different. Being one of the least winter hardy of the vetches, it has usually winterkilled in experimental plantings at stations in the Cotton Belt. The zero growing point or minimum temperature at which it will make growth is lower than for Austrian winter peas, hairy vetch, or smooth vetch, and in this respect purple vetch is desirable, but its lack of winter hardiness precludes its general use in the Cotton Belt.

BITTERVETCH

(*Vicia ervilia* (L.) Willd.)

Bittervetch has been used in the South only in experimental plantings. It is much more upright in growth than most other vetches

and in this respect is desirable, but it has made comparatively little growth and has often winterkilled, indicating that its use under Cotton Belt conditions at best will be limited.

BARD VETCH

(*Vicia monantha* Retz.)

The general habit of growth of bard vetch is similar to that of hairy and common vetch. In experimental plantings at a number

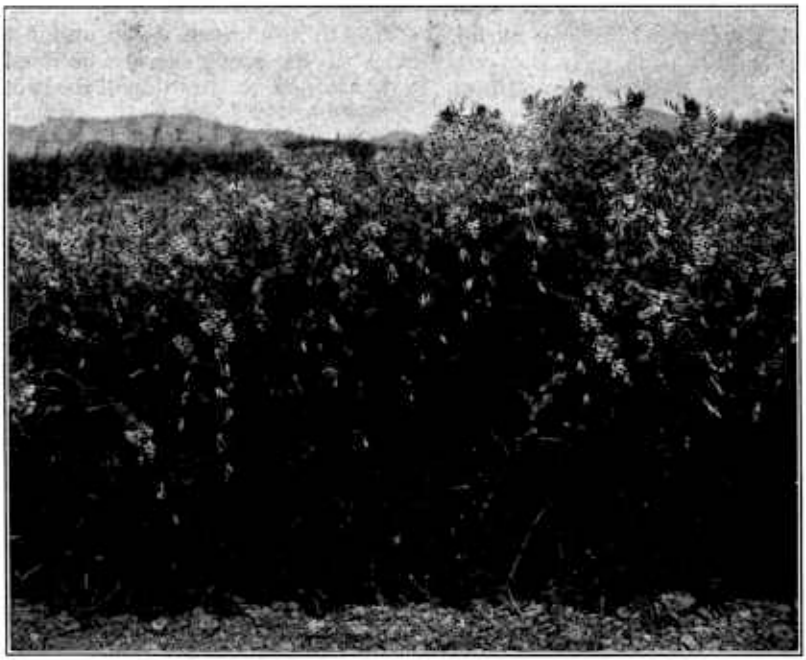

FIGURE 5.—Hungarian vetch in western Oregon, showing its general habit of growth.

of southern stations it has made very little growth, and it does not promise to be of much value under Cotton Belt conditions.

HORSEBEAN

(*Vicia faba* L.)

Although the horsebean is related to the vetches, it is quite different from most of them in general appearance. It is a coarse upright-growing plant having large, broad leaflets. There are a large number of varieties, but all require more or less the same general climatic and cultural conditions. The minimum temperature at which the horsebean will make growth is comparatively low, this plant being comparable to purple and monantha vetch in this respect. It usually produces a succulent growth in late fall or during warmer spells of the winter and is subsequently frozen and killed. Experience with the horsebean in the Cotton Belt has not indicated that it is to be recommended for use as a winter green manure.

TANGIER PEA

(*Lathyrus tingitanus* L.)

The general habit of growth of the Tangier pea is similar to that of the common garden sweet pea. In winter hardiness it is similar to monantha vetch, being much less hardy than hairy vetch or Austrian winter peas. The minimum temperature at which it will make growth is about the same as, or slightly lower than, hairy vetch. A very rapidly growing plant at moderate temperatures, it gives a heavy yield of green manure. Experimental plantings suggest that it will make good growth in most seasons in the southern part of the Cotton Belt, but it has not been found superior to monantha vetch and Austrian winter peas. As the seed habits of Tangier peas are poor and the cost of seed correspondingly high, its use no doubt will be very limited.

AUSTRIAN WINTER PEA

(*Pisum arvense* L.)

The variety of pea introduced to the trade several years ago under the name Austrian winter seems to be identical with the gray winter

FIGURE 6.—A good growth of Austrian winter peas in a pecan grove in southern Georgia.

variety. It is one of the most winter hardy of the pea varieties and makes good growth under Cotton Belt conditions. The plants are viny, ascending only with support. It has a low minimum growing point and in this respect is about like smooth vetch and woollypod vetch. It makes a good growth under southern winter conditions and is one of the best winter legumes for general use. It has a greater acreage planting than any other winter legume with the possible exception of hairy vetch. Commercial seed production has now reached about 50,000 acres (fig. 6).

BUR-CLOVER

(*Medicago* spp.)

Two species of bur-clover are grown in the Cotton Belt—southern bur-clover (*Medicago arabica* (L.) All.) and Tifton bur-clover (*M. rigidula* (L.) Desr.). The Tifton bur-clover is a recent introduction that has been grown and distributed from the Georgia Coastal Plain Experiment Station at Tifton, Ga., from which place it takes its name. Although it makes a decumbent growth and in general is like the southern bur-clover, it differs in having leaves of a darker green color and lacks the dark-purple spot in the middle of each leaflet characteristic of that species. It also is more winter hardy than the southern bur-clover. The California bur-clover (*M. hispida* Gaertn.)

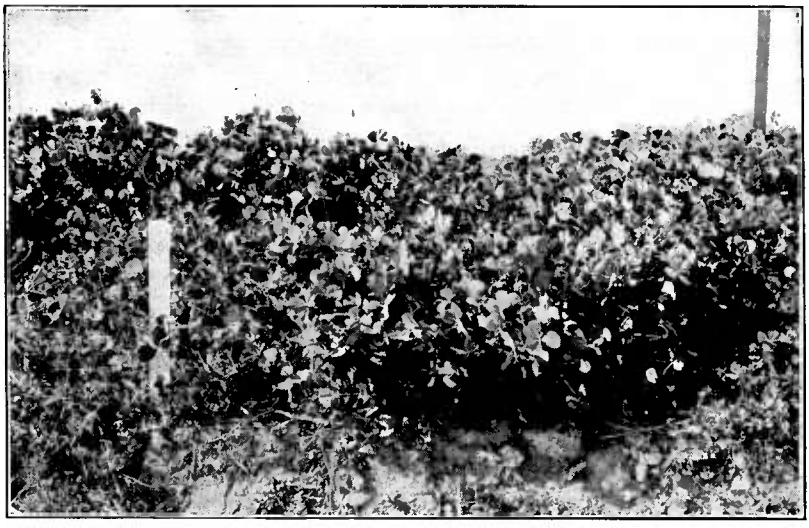

FIGURE 7.—A good growth of crimson clover about ready to turn down for green manure.

is occasionally sown in the Cotton Belt States, but usually without success, as it is less winter hardy than the Tifton or southern bur-clover and is often damaged severely by cold weather.

The minimum temperature at which the bur-clovers will make growth is somewhat higher than that of smooth vetch or woollypod vetch, but about the same as for hairy vetch.

CRIMSON CLOVER

(*Trifolium incarnatum* L.)

Crimson clover is recognized as a good winter legume, but it is sometimes difficult to get a good stand. This uncertainty has prevented a much wider use of the crop for green-manuring purposes. It is best adapted to the more northern part of the Cotton Belt and is used most extensively from northern Georgia and northern Alabama northward to New Jersey. It will not make growth at as low a temperature as Austrian winter peas and woollypod and smooth vetch, but at slightly higher temperatures it makes rapid growth (fig. 7).

SOURCLOVER

(*Melilotus indica* (L.) All.)

Sourclover is an upright-growing winter annual that has been used extensively for green manure in the southwestern United States. Its use in the Cotton Belt has been limited to the lower Mississippi Delta area and the black lands of Mississippi and Alabama, and it is not recommended for general use outside of this territory. It does not seem to be well adapted to other lands of the South and on such succeeds only with heavy applications of lime and superphosphate.

The minimum temperature at which sourclover will make growth is higher than for Austrian winter peas, smooth vetch, and woollypod vetch, and it has about the same temperature-growth requirements as bur-clover. The seed of sourclover usually has been cheap, and as only a small quantity is needed for seeding, it is a crop that can be grown with very little expense.

FENUGREEK

(*Trigonella foenumgraecum* L.)

Fenugreek has been grown for a winter green-manure crop in California, but it has never been grown successfully in the Southern States. In experimental plantings it has made little growth and seems to be unsuited to general southern conditions. Further experimental work may demonstrate limited areas to which it may be suited or indicate cultural practices that may make for success. The minimum temperature at which fenugreek will make growth is about the same as for bur-clover and sourclover, and it is much like these crops in winter hardiness.

SERRADELLA

(*Ornithopus sativus* Brot.)

Serradella is a semiviny plant more or less like the vetches in general habit of growth. It is used in Germany on sandy lands for soil improvement, but it has never been grown commercially in the United States. In experimental plantings in the South it has generally failed to make good growth, except in a few cases where the soil was well supplied with accumulated organic matter.

LUPINE

(*Lupinus* spp.)

Lupines have been used in European countries for soil improvement, but they have been grown very little in the United States. In Hungary and Germany they have proved especially valuable for green manure on sandy lands and have been grown extensively for this purpose. The white lupine (*Lupinus albus* L.), yellow lupine (*L. luteus* L.), and narrowleaf lupine (*L. angustifolius* L.) are the species most used. These are all upright-growing plants well suited for green manuring. In experimental plantings in most parts of the United States poor stands have usually resulted; however, very good growth is sometimes made, and in the past few years narrowleaf lupine has been grown successfully in commercial plantings in northwestern Florida and parts of southern Georgia and Alabama.

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